A NOTE ON THE YAMATO METEORITES COLLECTED IN DECEMBER 1969

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Abstract: This paper summarizes earlier studies on 9 "Yamato meteorites" which were discovered in December 1969 by an oversnow traverse party of the 10th Japanese Antarctic Research Expedition at the southeastern end of the Yamato Mountains in East Antarctica. The samples consisted of 8 chondrites and 1 achondrite, among which relatively large 4 samples were classified as follows: Yamato (a) enstatite chondrite, (b) Ca-poor achondrite, (c) carbonaceous chondrite (Type III), and (d) olivine-bronzite chondrite. Since the meteorites were found in the bare ice area of about 5×10 km, geomorphological and glaciological features of the sampling site are described in relation to the concentration of the meteorites.

In December 1969 a 10-man oversnow glaciology party of the 10th Japanese Antarctic Research Expedition (JARE) discovered 9 meteorites by chance near the Yamato Mountains in East Antarctica. This party was dispatched to install a glaciological triangulation chain along the parallel of 72°S in order to measure the surface flow vectors and surface strain of the ice sheet in the head region of the Shirase Glacier. When the party approached the datum points established on nunataks near the Yamato Mountains, they found the meteorites on the surface of ice sheet free from snow (bare ice) in a very limited area of about 5×10 km.

YOSHIDA *et al.* (1971), who were the members of this glaciology party, gave a brief description on the occurrence of the meteorites and preliminary petrological identification that 9 samples consisted of 8 chondrites and 1 achondrite. Further, relatively large 4 samples were subjected to petrological, mineralogical, and chemical analyses by Masako SHIMA *et al.* (1973) and Makoto SHIMA *et al.* (1974). Those 4 samples were designated as Yamato (a), (b), (c) and (d), among which Yamato (b) was achondrite. The remaining samples were designated as Yamato (e), (f), (g), (h) and (i). These 9 Yamato meteorites are listed in Table 1. As was regretted by YOSHIDA *et al.* (1971), only two locations and sampling dates were kept in record.

The present report summarizes these earlier studies and gives recent information of geomorphology and glaciology of the sampling site of the Yamato meteorites.

Figure 1 shows the sampling locality of the Yamato meteorites, together with the traverse routes of the glaciology party of the 10th JARE. The party left Syowa Station on November 1, 1969 and arrived at station S240 located at 72°00′S

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Table 1. Yamato meteorites collected in December 1969.
(After YOSHIDA et al., 1971 ; SHIMA et al., 1973 and 1974)

Designation	Initial sample number	Initial weight (g)	Date (December)	Classification
Yamato (a)	1	715	21	Enstatite chondrite
Yamato (b)	2	138	21	Ca-poor achondrite
Yamato (c)	3	150	One day between 21 and 26	Carbonaceous chondrite (Type III)
Yamato (d)	4	62	〃	Olivine-bronzite chondrite
Yamato (e)	5	38	〃	Chondrite
Yamato (f)	6	41	〃	〃
Yamato (g)	7	25	〃	〃
Yamato (h)	8	10	〃	〃
Yamato (i)	9	10	〃	〃

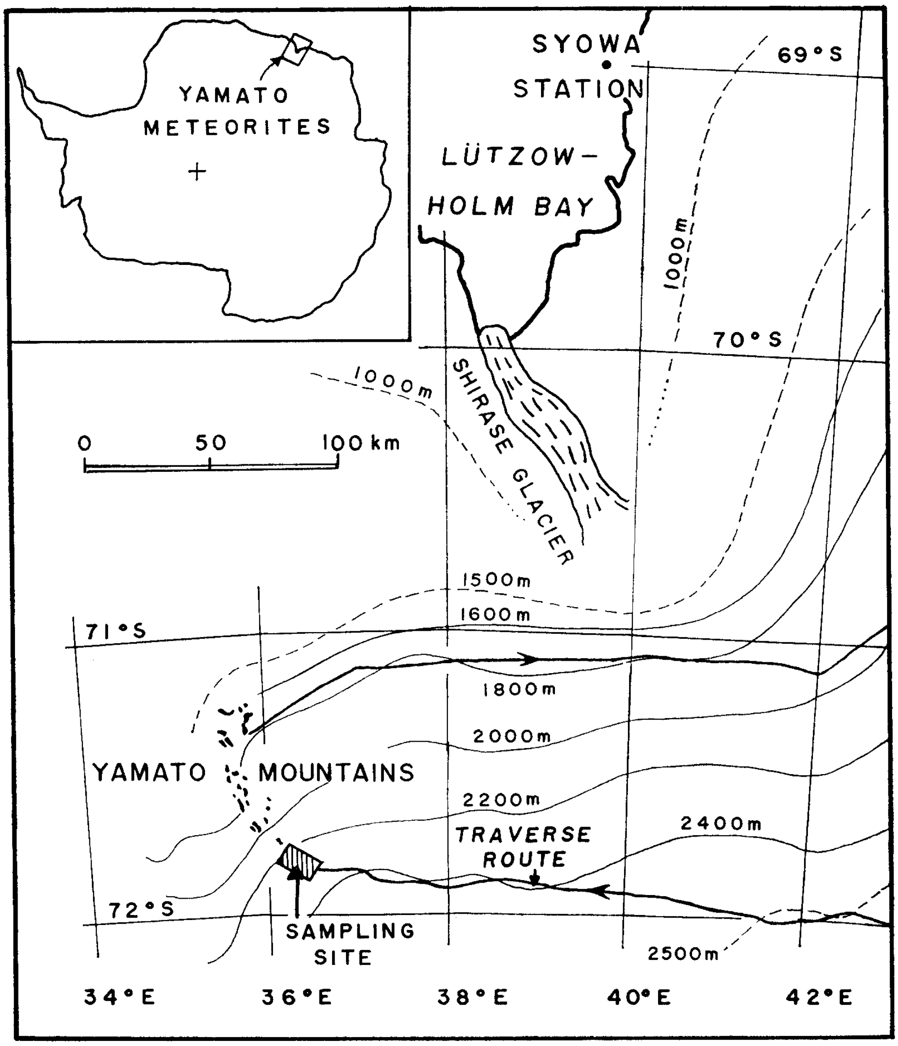

Fig. 1. Location of Yamato meteorites sampled in December 1969.

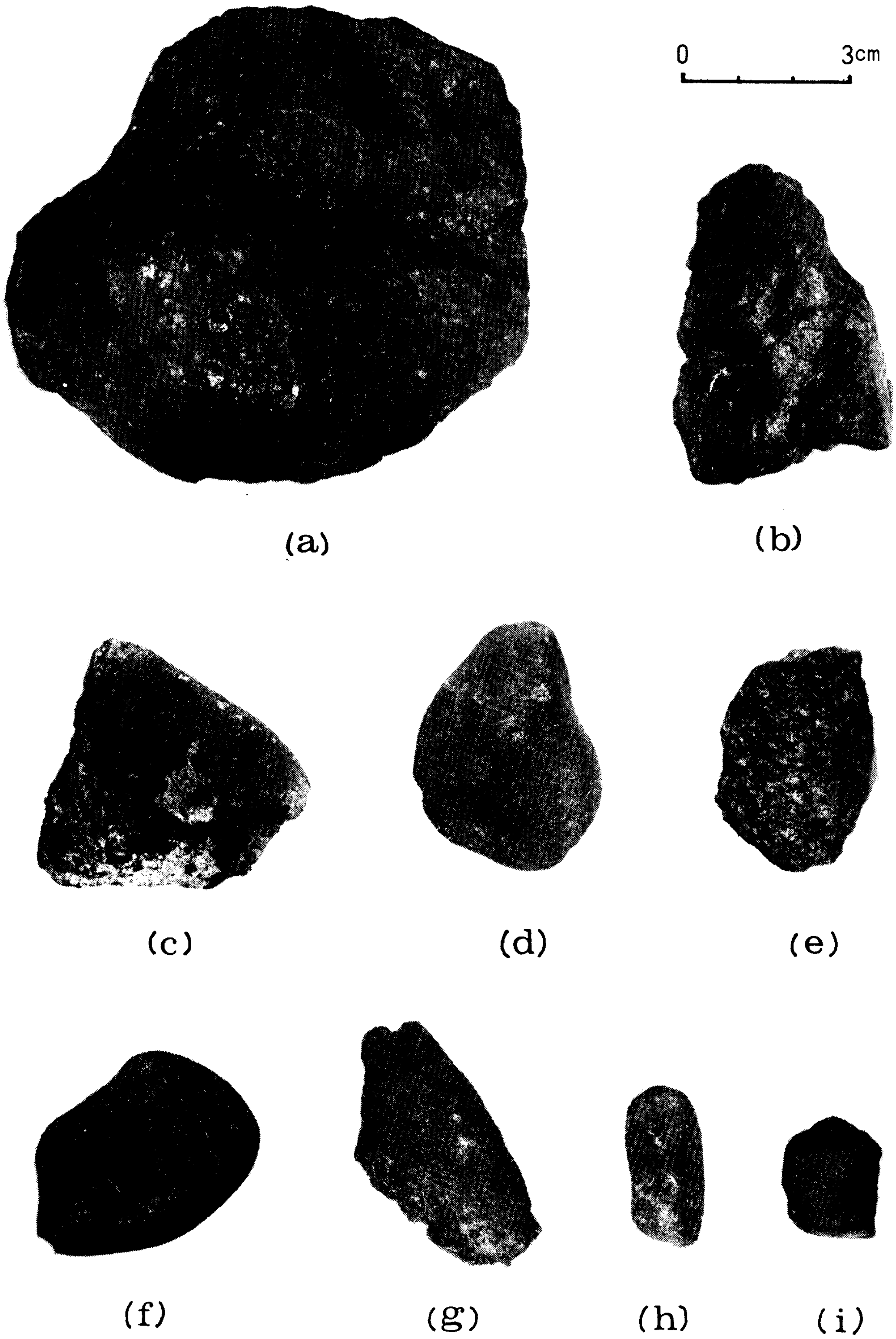

Fig. 2. Photographs of nine Yamato meteorites.
(By the courtesy of M. YOSHIDA. Photograhed by M. GORAI).

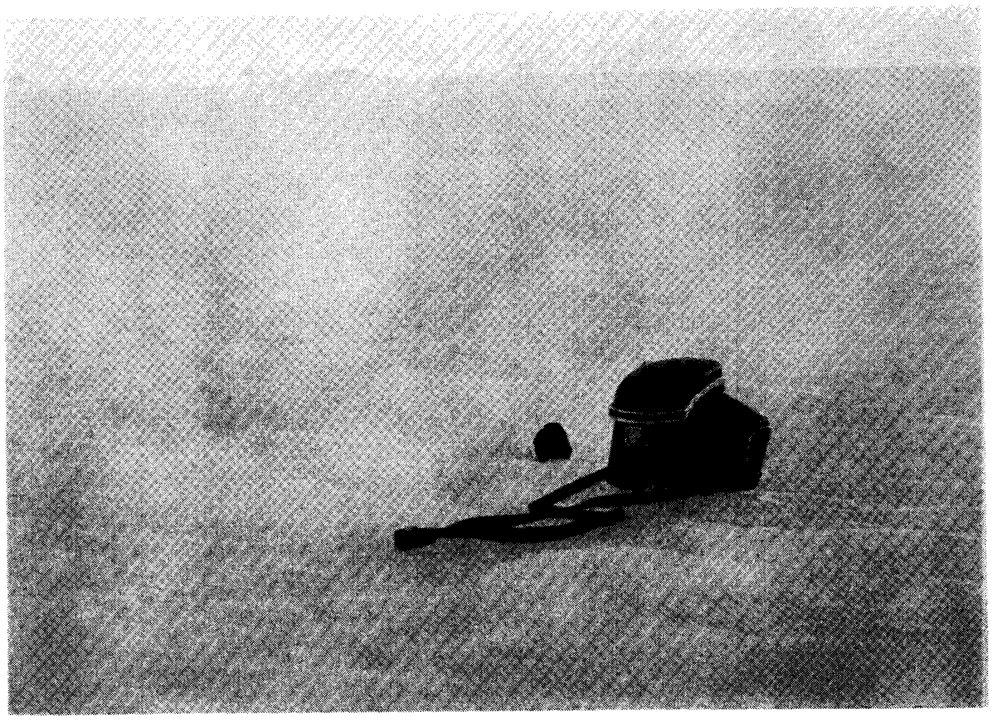

Fig. 4a. Yamato (b) photographed on the actual location.

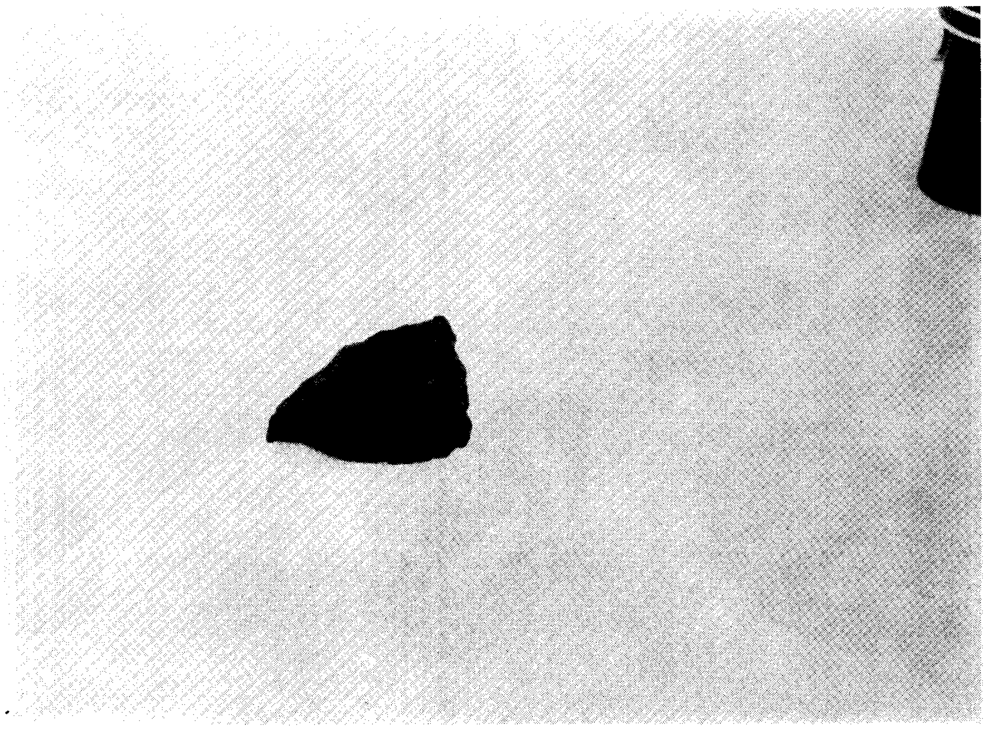

Fig. 4b. A close-up of Yamato (b).
(By the courtesy of M. Yoshida. Photographed by Y. Ageta).

and 43°10′E on November 21. Leaving S240 (later designated as A164) on November 24 and installing about 250 km long triangulation chain along the parallel of 72°S, the party arrived at the datum point A001 established on an exposed rock near the Yamato Mountains on December 31 (NARUSE *et al.*, 1972). This chain was resurveyed in the austral summer of 1973–1974.

Elevation contours in Fig. 1 suggest a general northward flow of the ice sheet and a converging flow into the Shirase Glacier which is the largest outlet in this region. There are several outlet glaciers flowing from E to W between the nunataks in the Yamato Mountains. In this area, streaks of moraine fields also run from E to W or SE to NW. Bare ice fields are found only in the vicinity of the Yamato Mountains, both in the eastern and western sides.

The party made the first discovery of stony meteorite, the Yamato (a), at the eastern end of bare ice area on December 21, thenceforth a total of 9 samples were collected till December 26. Photographs of 9 Yamato meteorites are shown in Fig. 2.

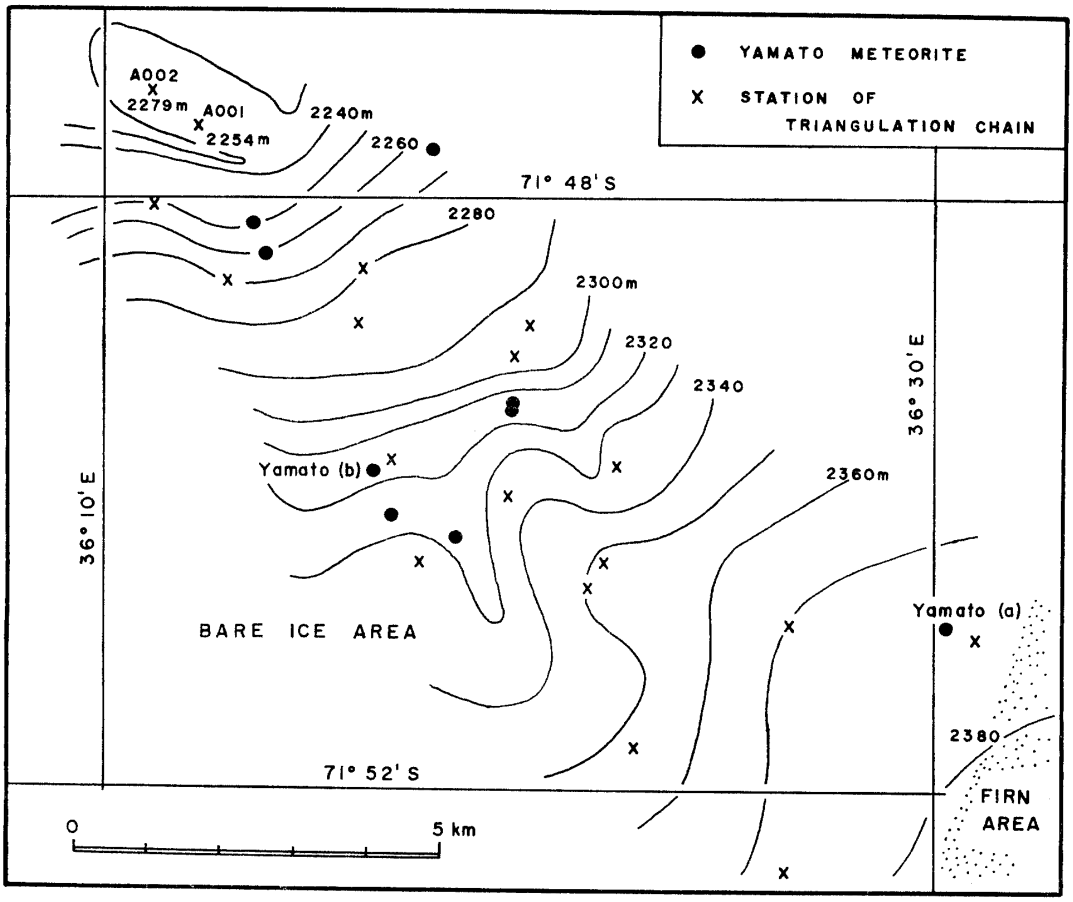

Fig. 3. Sampling site of nine Yamato meteorites at the southeastern end of the Yamato Mountains.

In Fig. 3, locations of 9 Yamato meteorites and stations of triangulation chain are illustrated. The positions of the meteorites are the same as those in the map of YOSHIDA *et al.* (1971), an error of positions being about 500 m. However, the elevation contours in Fig. 3 were drawn from new data prepared by NARUSE *et al.* (1972); they computed elevations of stations of triangulation chain with reference to the geodetic positions and adjusted barometric heights of two datum points, A001 and A002, giving 2254 m and 2279 m in height respectively. Adopted position of A001 was 71°47′28.1″S and 36°12′12″E, which was determined by astronomical observations. It is to be remarked that the elevations given in Fig. 3 are about 120 m lower than those given by YOSHIDA *et al.* (1971) who used approximate barometric heights.

The sampling site of the Yamato meteorites shown in Fig. 3 is practically free from snow and has a fairly steep slope lowering towards NW, from 2380 m at the eastern margin to 2230 m around the datum points area. This surface morphology indicates a general ice sheet flow towards the Yamato Mountains. The thickness of ice sheet varies from about 1000 m at the eastern margin to 400–500 m near the datum point A001.

In Fig. 4, photographs of Yamato (b) taken at the sampling site are shown. No snow cover is seen on the location, except a very tiny snow drift on the lee of the meteorite. YOSHIDA *et al.* (1971) reported that there was a very conspicuous contrast between dark meteorite sample and white bare ice, which made the discovery easy.

One would at once raise a question why as many as 9 meteorites were found within such a limited area of about 5×10 km. Taking a hint from the existence of moraine fields at the eastern margin of the nunataks of the Yamato Mountains, YOSHIDA *et al.* (1971) suggested that the movement and the structure of the ice sheet in the area may account for the concentration of the meteorites and that more may be found in this area. SHIMA *et al.* (1973) also inferred the cause of concentration of meteorites in a narrow area, and suggested three possibilities: a single shower of meteorites from a parent body; different kinds of meteorites fell at different times in a limited area; meteorites, which had fallen in a wide upstream region, were carried to the present narrow area by ice sheet movement. As shown in Table 1, there are different kinds of chondrites and one achondrite, so the possibility of a single shower from one parent body was ruled out. They obtained different values in the ages of solidification and exposure of Yamato (a), (b), (c) and (d), which also ruled out the possibility of one shower (SHIMA *et al.*, 1974).

In order to elucidate the role of ice sheet movement in the concentration of meteorites in the vicinity of the Yamato Mountains, it is necessary to carry out a systematic and comprehensive search for meteorites and glacio-geomorphological studies. The glaciology party of the 14th JARE resurveyed the triangulation chain and found 12 meteorites in December 1973, among which 8 samples were collected in the same bare ice area where the first discovery was made in 1969 (SHIRAISHI *et al.*, 1975).

In November and December 1974, a systematic search was made in this area as well as the western side of the Yamato Mountains; the traverse party of the 15th JARE was rewarded by the collection of more than 650 samples among which the largest one was about 20 cm in diameter. Details will be reported in the very near future.

Results of resurvey of the triangulation chain indicated that the surface flow speed of the present sampling site was less than 2 m/year at the eastern margin and less than 0.5 m/year near the datum points, which disclosed the evident deceleration of the ice sheet movement due to the Yamato Mountains (NARUSE, 1975). The average direction of the surface flow was to NW. These small surface speeds are about 1/10 of those in the more eastern part of the chain.

An average net ablation of 5.2 cm/year in terms of ice thickness was obtained between 1969 and 1973. This ablation will aid the exposure of meteorites buried in the ice and may contribute to the concentration of meteorites in this bare ice area. It does not necessarily follow that the meteorites buried in the ice were brought onto the surface, because small samples can be transported by the wind. Surface weather data obtained by the traverse party of the 10th JARE indicated an average wind speed of 10 m/sec and prevailing wind direction of E (AGETA, 1971).

In view of the rich harvest in 1974, it is quite probable that more will be found in the vicinity of the Yamato Mountains, particularly in the bare ice areas. In order to present a more elaborate interpretation of the mechanism of the concentration of meteorites into this specified area, a more detailed glaciological survey in the field and the continuation of laboratory studies are necessary.

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References

AGETA, Y. (1971): Higashi-nankyoku Mizuho-kôgen fukin no kishô jôtai ni tsuite (Some aspects of the weather conditions in the vicinity of the Mizuho Plateau, East Antarctica). Nankyoku shiryô (Antarct. Rec.), **41**, 42–61.

NARUSE, R. (1975): Movement of the ice sheet measured by a triangulation chain in Mizuho Plateau, 1973–74. JARE Data Rep., **28** (Glaciology) (In press).

NARUSE, R., A. YOSHIMURA and H. SHIMIZU (1972): Installation of a triangulation chain and a traverse survey line on the ice sheet in the Mizuho Plateau-West Enderby Land area, East Antarctica, 1969–1970. JARE Data Rep., **17** (Glaciology), 111–131.

SHIMA, M(asako), A. OKADA and M(akoto) SHIMA (1973): Nankyoku ni okeru uchû busshitsu ni kansuru kenkyû (III) Inseki ni tsuite (Study of the extraterrestrial materials in Antarctica, III. On the Yamato meteorites). Nankyoku shiryô (Antarct. Rec.), **47**, 86–97.

SHIMA, M(akoto), A. OKADA and M(asako) SHIMA (1974): Nankyoku ni okeru uchû busshitsu ni kansuru kenkyû (IV) Yamato inseki ni tsuite (Ditto, IV. On the Yamato meteorites). Nankyoku-shiryô (Antact. Rec.), **48**, 91–99.

SHIRAISHI, K., R. NARUSE and K. KUSUNOKI (1975): Collection of Yamato meteorites, Antarctica, in December 1973 (Unpublished)

YOSHIDA, M., H. ANDO, K. OMOTO, R. NARUSE and Y. AGETA (1971): Discovery of meteorites near Yamato Mountains, East Antarctica. Nankyoku shiryô (Antarct. Rec.), **39**, 62–65.

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